Frequency discretization in dielectrophoretic assisted cell sorting arrays to isolate neural cells.

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Public Summary:
The inability to separate stem cells and their differentiated progeny accurately, easily, and rapidly undermines progress in the stem cell field. Traditional separation of living cells into subpopulations relies on techniques that utilize characteristic cell surface markers, but specific markers are severely limited or lacking altogether for many stem cell populations. Without ways to discriminate and isolate subpopulations of stem cells and their derivatives, controlling the purity of cells for in vitro studies or transplantation is impossible. A different method termed “dielectrophoresis” (DEP) may provide a label-free and unbiased method to address these stem cell sorting issues. DEP employs a non-toxic electric field to attract or repel cells in a frequency-dependent manner independent of marker expression. We present an automated cell sorting device for characterization and isolation of neural cells using DEP. We report the first statistically significant neuronal sorting using dielectrophoretic assisted cell sorting (DACS) to enrich neurons from a heterogeneous population of neural stem/progenitor cells (NSPCs) and neurons. We also study the dielectric dispersions within a heterogeneous cell population using a Monte-Carlo (MC) simulation. This simulation explains the behavior of cell populations as a function of DEP frequency and predicts sorting efficiencies. The platform consists of a DEP electrode array with three trapping regions that can be independently activated at different frequencies. A novel microfluidic manifold enables cell sorting by trapping and collecting cells at discrete frequency bands rather than single frequencies. The device is used to first determine the percentage of cells trapped at these frequency bands. With this characterization and the MC simulation we chose the optimal parameters for neuronal sorting. Cell sorting experiments achieved a 1.4-fold neuronal enrichment as predicted by our model.

Scientific Abstract:
We present an automated dielectrophoretic assisted cell sorting (DACS) device for dielectric characterization and isolation of neural cells. Dielectrophoretic (DEP) principles are often used to develop cell sorting techniques. Here we report the first statistically significant neuronal sorting using DACS to enrich neurons from a heterogeneous population of mouse derived neural stem/progenitor cells (NSPCs) and neurons. We also study the dielectric dispersions within a heterogeneous cell population using a Monte-Carlo (MC) simulation. This simulation model explains the trapping behavior of populations as a function of frequency and predicts sorting efficiencies. The platform consists of a DEP electrode array with three multiplexed trapping regions that can be independently activated at different frequencies. A novel microfluidic manifold enables cell sorting by trapping and collecting cells at discrete frequency bands rather than single frequencies. The device is used to first determine the percentage of cells trapped at these frequency bands. With this characterization and the MC simulation we choose the optimal parameters for neuronal sorting. Cell sorting experiments presented achieve a 1.4-fold neuronal enrichment as predicted by our model.